

## References

1. O.A. Guselnikova, A.I. Galanov, A.K. Gutakovskii, P.S. Postnikov // *Beilstein J. Nanotechnol.*, 2015.– 6.– 1192–1198.
2. Ya.N. Ertas, N.N. Jarenwattananon, and L.-S. Bouchard // *Chem.Mater.*, 2015.– 27.– 5371–5376.
3. Guselnikova O.A., Gromov M.V., Galanov A.I. // *Advanced Materials Research.– Trans Tech Publications*, 2014.– Vol.1040.– P.309–313.
4. K. Hayashi et al., *ACS Biomater. Sci. Eng.*, 2017.– 3(1).– P.95–105.

## SYNTHESIS OF LACTIC ESTERS

Y.B. Lugovskaya, Y.E. Poharukova

Scientific supervisor – PhD, Associate Professor V.T. Novikov

National Research Tomsk Polytechnic University

634050, Russia, Tomsk, Lenin Avenue 30, [julka250393@mail.ru](mailto:julka250393@mail.ru)

Nowadays production of lactic esters is one of the challenges in the modern organic chemistry. The esters form a part of essential oils composition specifying their pleasant smell [1], they are used in food and perfumery industry [2]. The esters include a lot of biologically important substances and medications [3]. The most promising esters application results their usage as plasticizers for medical materials production based on polylactide.

Lactic esters are synthesized via the following methods:

1. Esterification of lactic acid with alcohol in the presence of acidic catalyst. Para-toluene sulfonic acid, boric, phosphoric, sulphuric and other acids are used as a catalyst to increase a reaction rate of esterification without affecting an equilibrium state.

To change the equilibrium state and to enhance the yield of esters the following methods are used:

- The use of one of the starting materials in excess. Usually, the concentration of more accessible reagent – an alcohol is increased.
- The ether or water removal forming in situ. For a low-boiling ester synthesis the ester is driven off in situ. For a high-boiling ester synthesis it is preferable to drive off a water in situ. The water is driven off in the form of azeotropic mixture with the vapor of the corresponding alcohol.

It is undesirable to use the 98% of lactic acid as the initial product because its presence in the concentration process leads to a partial lactonization [4].

2. Alcoholysis of polylactic acid. It is very similar to the hydrolysis reaction, only with the alcohol as a substitute for the water. Since the reaction

is catalytic, sodium alkoxide, sodium hydroxide and potassium carbonate are used as catalysts.

The first problem of using this method is a relatively low yield of a target product. Moreover, an additional catalyst purification stage is required to eliminate a residue.

3. Esters synthesis from alpha-halogen derivatives of lactic acid. This method is unprofitable, as it requires a high operation costs and complex equipment [5].

As it was presented above, the lactic ester synthetic roots have a number of limitations. In view of this, an improve of existing methods or a search of new techniques is of particular relevance nowadays. This article presents the advanced isopropyl and butyl lactic esters synthetic procedure.

The process is based on esterification reaction of lactic acid with the corresponding alcohol in the presence of acid catalyst.

A solution of 80% L-lactic acid (M.C.D Import&ExportGmbH., Germany) [6, 7], isopropyl or butyl alcohol were chosen as raw materials. Benzene or butyl acetate performed a role of solvent, whereas sulfuric acid acted as a catalyst.

The simple distillation unit was used for ester synthesis during 10–16 hours with the stage of triple mixture removal (the solvent – corresponding alcohol – water) and binary mixture (alcohol – solvent). Calcium carbonate or sodium bicarbonate were additionally introduced into the mixture to remove the excess of alcohol and solvent. The flask content was filtered, the obtained filtrate was distilled.

The isopropyl ester of lactic acid was distilled in the temperature range of 75–80 °C, resulting in 25–30% of product yield. As for the butyl ester,

it was distilled in the temperature range of 187–188 °C. The yield of corresponding product reached 30–35%.

## References

1. Bogomolova I.V., Makarikhina S.S. *Organic chemistry*. – M.: Flinta, 2013. – 365p.
2. Kawashima N et al. // *Jap. Polym. SCI. I Tekhnol.*, 2005. – Vol.62. – №6. – P.233–241.
3. Pang, X., Zhuang X., Tang J., Chen X. Pang // *Biotechnol. J.*, 2010. – Vol.5. – P.1125–1136.
4. Pat. 923095, Int. CL. 2863614/04. *A method of producing esters of lactic acid* / Kamalyan, K. S., Avagyan T.G. – date of the patent. 27.06.1995.
5. Pat. 2302618 / 2480586, USA, Int. CL. A61B5/0408. *The preparation of organic esters* / Preparation of alpha-alkoxy acids and esters / Donald. I. Loder; Wilmington. – The date of the patent. 19.01.1973.
6. Yarkova A.V., Novikov V.T., Shkarin A.A., Poharukov Y.E., et al. // *Universities. Chemistry and Chemical technology*, 2014. – Vol.57. – №11. – P.66–68.
7. Yarkova A.V., Shkarin A.A., Zinovyeva A.L., Novikov V.T. // *Bulletin of the Tomsk state University. Chemistry*, 2015. – Vol.1. – P.65–71.

## EVALUATION OF CATALYST DEACTIVATION DEGREE AT THE INDUSTRIAL DEWAXING UNITS USING THE METHOD OF MATHEMATICAL MODELLING

A.S. Lutsenko, N.S. Belinskaya, E.V. Frantsina  
Scientific supervisor – DSc, professor E.D. Ivanchina  
Linguistic advisor – PhD, Assistant lecturer N.S. Belinskaya

National Research Tomsk Polytechnic University  
634050, Russia, Tomsk, Lenin avenue 30, Lutsenko\_A\_S@mail.ru

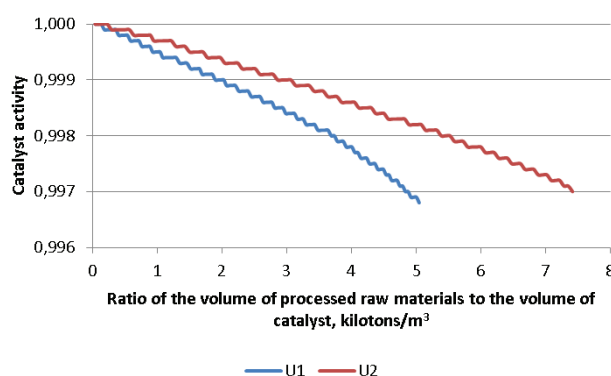
The actual problem of catalytic hydrodewaxing, as well as other catalytic processes, is to increase the operation life of the catalyst. This problem absorbs up to 90% of all funds for development and exploitation. The technology and design of catalytic processes are completely dictated by the problem of the catalytic deactivation. These include processes such as cracking, isomerization, all processes of dehydrogenation, hydrotreating, etc. [1]. Reducing the activity of the catalyst is equivalent to reducing the capacity of unit. Reducing selectivity of catalyst is equivalent to over-consumption of raw materials and energy and it is equivalent to reducing the quality of the target product.

In this study, the degree of deactivation of identical catalysts (HYDEX-G, extrudate shape 2.5 mm) of two hydrodewaxing units was compared using mathematical model [2]. The following abbreviations were introduced: U1 is the hydrodewaxing unit of the Ltd "KINEF"; U2 is the hydrodewaxing unit of OJSC "ANPZ VNK". For the research, the following data was used: technical characteristics of reactors, industrial operating data of units, data characterizing the quality of raw materials and products (group and fractional compositions, raw

In addition, IR-spectra of the obtained products were carried out using infrared spectroscopy (IR - Fourier spectrometer «SIMENS FT-801»).

and product densities, sulfur and nitrogen content etc.). The catalyst deactivation study was carried out during the operation of the units from 06.10.16 to 25.01.2017.

The total volume of processed raw materials of U1 and U2 for the period is 685 and 700 thousand m<sup>3</sup> respectively (Table 1). The raw materials processed at U1 are heavier and, probably, the deactivation rate of the U1 catalyst should be higher. However, in fact, during the testing period of oper-



**Fig. 1.** The graph of the dependence of the activity of the catalyst on the volume of raw materials processed by the 1 m<sup>3</sup> of volume of the catalyst